

## PATENT SPECIFICATION

DRAWINGS ATTACHED

L016,649



L016,649

Date of Application and filing Complete Specification May 21, 1964.

No. 21127/64.

Application made in United States of America (No. 283907) on May 28, 1963.

Complete Specification Published Jan. 12, 1966.

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Index at acceptance: —F4 G12A; B4 B(11A3, 16D); B5 K3; B5 N(2C, 2M4, 2N3, 2N6, 5G10, 10B3)

Int. Cl.:—F 26 b/B 29 c, d, B 31 f

## COMPLETE SPECIFICATION

## Dryer Belt and Method of Making Same

- We, HUYCK CORPORATION, a corporation organized under the laws of the State of New York, United States of America, of Washington Street, Rensselaer, State of New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- 5 This invention relates to an improved belt for use in the drying section of paper making machines, and to a method of producing such belt.
- 10 Dryer belts and methods of producing such belts of the type to which the present invention is directed, while of general application, are particularly well suited for use in connection with the production of non-woven fibrous products such as paper, paperboard, box-board, and related products, in a paper-making machine. As is well known, such machines customarily include a so-called "wet" section and one or more drying sections. The paper product is formed from a web of water-saturated pulp which is transported by one or more papermakers' wet felts through opposed press rolls and other de-watering devices in the wet section of the machine until the moisture content of the web is reduced and its fiber structure compacted to such a point that it may become substantially self-supporting. The web is then received by one or more dryer belts, which heretofore customarily have been in the form of a felt or other woven fabric, and is carried around a series of rotating dryer drums in the drying section of the machine. These drums are arranged to apply heat to the web to remove the remaining moisture.
- 40 Papermaker's dryer belts serve to hold the paper web in intimate contact with the heating surfaces of the rotating dryer drums to promote heat transfer and to prevent cockling or wrinkling of the web while being dried. Such belts should be flexible and heat resistant with good dimensional stability and durability under the conditions of tension, temperature, and related properties, customarily encountered in the drying section of the paper machine. The belts also must have a smooth surface finish appropriate for the particular fibrous product being produced. These characteristics should be realized while at the same time maintaining the cost of the belts to the paper manufacture at a minimum.
- 55 Heretofore, the most widely used dryer belts have been woven from either natural or synthetic yarns to form a relatively bulky fabric. It was generally considered necessary that the fabric have good absorbent characteristics and high porosity to enhance the removal of moisture from the web of material being dried. While smooth surface finish was recognized as a desirable property, it was felt that the fabric should have sufficient roughness so that it could be easily driven and guided during its movement around the dryer drums of the machine.
- 70 In the manufacture of dryer belts of the type previously employed, difficulties were encountered in the realization of belts having the optimum drying characteristics. For example, particularly in cases in which the belts were of woven construction, compromises had to be made between what was desired in the way of dimensional stability, durability, surface finish, porosity, and related properties, because emphasis upon certain of these characteristics necessitated the sacrifice of others. As an illustration, for applications in which it was felt that the belts should have high porosity, a comparatively open weave fabric was employed, with the attendant reduction in dimensional stability, durability and surface finish. To improve these latter characteristics, the yarns were woven closer together to form a comparatively dense fabric, with the result

[Price 4s. 6d.]

that the range of available porosities often was too low. Moreover, primarily because of the highly absorbent, compressible nature of many prior belts, the belts exhibited a tendency to rewet the sheet being dried and were difficult to keep clean. In addition, even though dryer belts of the type used heretofore frequently included asbestos or other heat resistant fibers, their resistance to the heat from the dryer drums in many cases proved deficient. Furthermore, difficulties frequently were encountered heretofore in the joining of the ends of the belts to provide an endless construction.

The difficulties experienced with dryer belts of traditional construction were often compounded by their comparatively high cost. In many cases, the belts required expensive textile processing operations, including the use of large and costly looms. Also, substantial quantities of relatively expensive fibers were needed, the cost of which was further increased when fibers having good heat resistant properties were employed.

In accordance with the present invention, there is provided a dryer belt for the drying section of a paper making or similar machine, which belt is adapted to be moved in an endless path in said machine and is formed of material permitting the transmission of moisture therethrough from said web, the material comprising substantially incompressible polymeric sheet material.

The invention also provides a method of producing a dryer belt adapted to be moved in an endless path in the drying section of a papermaking or similar machine, characterized by forming a sheet of substantially incompressible polymeric material such as polyethylene terephthalate and joining the end portions of said sheet to form a belt movable in an endless path.

Thus, this invention provides a belt and method of the character indicated in which the belt exhibits broadened porosity characteristics, greater dimensional stability, increased durability and good finish properties in much broader ranges of combination than dryer belts heretofore available.

With this invention, such belt and method is provided in which the amount of moisture absorbed by the belt material is substantially reduced and in some cases eliminated.

The invention further provides a belt for the drying section of a paper machine which exhibits greater resistance to heat and chemical deterioration than many types of dryer belts employed heretofore. The tendency of the perforations in the belt to fill up with fiber from the paper web and thus require frequent cleaning also is substantially reduced.

The invention provides a dryer belt which is extremely economical to manufacture and thoroughly reliable in operation.

Another feature of the invention, is that perforations are formed in the belt material

of a size and orientation sufficient to enable extremely efficient transmission of moisture through the belt from the paper web. In some embodiments, the perforation arrangement is such that uninterrupted paths of the material extend in a lengthwise or machine direction, thereby further preserving the material's good durability characteristics.

The present invention will now be described in greater detail with reference to the accompanying drawings, in which:

Figure 1 is a side elevational view, partially broken away, of portions of the drying section of a paper making machine, together with representative web-carrying belts in accordance with the invention;

Figure 2 is an enlarged plan view of a portion of a web-carrying belt in accordance with one illustrative embodiment of the invention;

Figure 3 is an enlarged vertical sectional view of the belt shown in Figure 2, together with a schematic representation of suitable perforating apparatus;

Figure 4 is an enlarged vertical sectional view of a portion of a laminated belt in accordance with another illustrative embodiment of the invention;

Figure 5 is an enlarged vertical sectional view of a portion of a laminated belt in accordance with a further illustrative embodiment of the invention;

Figure 6 is a plan view, partially broken away, of the ends of a web-carrying belt showing a representative connection therebetween;

Figure 7 is an enlarged vertical section view of a portion of the belt shown in Figure 6, along with a schematic illustration of representative apparatus for effecting various seals;

Figure 8 is an exploded plan view of the ends of a web-carrying belt showing another representative connection therebetween;

Figure 9 is a longitudinal sectional view taken along the line 9—9 in Figure 8;

Figure 10 is an exploded plan view in general similar to Figure 8 but showing a third representative connection between the ends of the belt; and

Figure 11 is a longitudinal sectional view taken along the line 11—11 in Figure 10.

The dryer belts described herein preferably are fabricated from thermoplastic polymeric sheet materials having a substantially crystalline structure and a comparatively high softening or distortion point. Such materials exhibit little or no compressibility, either in their unstressed condition at room temperature or under the conditions of tension, temperature and flexure customarily encountered in the drying section of a paper making machine. In the operation of some types of machines, the temperature of the dryer drums may approach about 300°F., and in these cases

the softening point of the material should be well in excess of this temperature. In addition, the material advantageously is substantially non-absorbent. As a result, the moisture from the paper web passes through the perforations and is not retained within the material of the belt, thereby reducing the possibility of transmitting moisture from the material back to the web.

One illustration of an incompressible polymeric sheet material which is of particular utility in connection with the invention is polyethylene terephthalate. This material is exemplified by the line of products commercially available from E. I. duPont de Nemours and Company, Wilmington, Delaware, and sold under its trademark Mylar. Such products are referred to herein as Mylar polyester film and are characterized by their crystalline structure, high heat resistance, extremely smooth surface finish and good tensile strength. The melting and distortion points lie within the range of from about 380°F. to 490°F., well above the temperatures encountered in the drying sections of conventional paper making machines. Because conventional sealing operations have little utility when applied to Mylar polyester film, difficulties heretofore were encountered in joining the ends of the material to form an endless belt, and these difficulties were of special moment in cases in which a smooth surface was desired in the vicinity of the joint. However, because of the unique joining means described hereinafter, exceedingly smooth belt surfaces are provided which substantially reduce any possibility of marking the paper web.

Of the various types of Mylar polyester film presently available, Type "A" and Type "T" have exhibited particular utility as dryer belts. Type "A" is biaxially oriented, having substantially equal properties in both the longitudinal or machine direction and in the transverse or cross direction. It has extremely good dimensional stability and exhibits little or no elongation or shrinkage under the widely varying conditions of tension, temperature and pressure in the drying section of the machine. Type "T" has unusually high tensile strength in the machine direction and is particularly useful in cases in which the machine is operated at high speed or in the manufacture of some of the heavier paper products such as paperboard, for example.

Mylar polyester film customarily ranges in thickness from about 0.25 mils to about 14.0 mils for single ply construction. However, when used as dryer belts in accordance with several advantageous embodiments of the invention, it has been found that two or three plies often are advantageous and that the thickness of the belts should range between about 5.0 mils and 28.0 mils for optimum

operating characteristics, and preferably between about 7.5 mils and 14.0 mils.

Other polymeric materials useful in the formation of dryer belts in accordance with the invention include polyamide polymers, e.g. the nylons designated as Type 6, Type 66 and HT-1, various polycarbonate polymers, vinyl polymers such as polyvinyl fluoride or polytetrafluoroethylene, for example, and various varieties of vinylidene polymers. Representative of suitable polymers of this latter class are polymers of vinylidene bromide, vinylidene chlorobromide, vinylidene cyanide and vinylidene halocyanide. These and other monomers also may be copolymerized to form copolymers such as vinylidene chloride-vinyl chloride, for example.

As best shown in Figure 1, rectangular sheets of Mylar polyester film are arranged to form a top belt 15 and a bottom belt 16 in the drying section of a paper making machine. The belt 15 extends over a plurality of upper tier dryer drums or cans 20, while the belt 16 is trained around a series of lower tier dryer cans 21. These belts serve to hold a running web 22 of paper against the cans 20 and 21 during its passage through the drying section. The cans 20 and 21 are internally heated by steam under pressure to a temperature which in many machines may be about 300°F. As will be understood, at the time the paper web 22 enters the infeed or wet end of the drying section (that is, the left end, as viewed in Figure 1), the web has been formed in the forming section of the machine and has been conducted through various dewatering devices in the wet section. In the drying section, the belts 15 and 16 hold the web in contact with the cylindrical surfaces of the cans 20 and 21, thereby enhancing the transfer of heat therefrom and preventing the web from wrinkling or cockling as it dries. At the time the web reaches the outfeed end of the dryer, it customarily has a moisture content which is under ten per cent, wet basis, and in most cases is substantially in its finished form. By per cent moisture content "wet basis" is meant the weight of the water in the web as it leaves the dryer section divided by the total weight of a water saturated web times 100, as determined by the procedure described in ASTM (American Society for Testing Materials) Standards for Textile Materials, Tentative Methods for Quantitative Analysis of Textiles, ASTM designation D629-59T, pages 317-8, 31st Ed., published Nov., 1960.

The belts 15 and 16 are of endless construction and are supported by a series of guide rolls, stretch rolls and carrying rolls in the drying section of the paper machine. Thus, the top belt 15 is disposed over a pair of guide rolls 26 and 27, around two stretch rolls 28 and 29 and over a series of carrying rolls 30. The pillow block and shaft bearing

(not visible in Figure 1) at one end of each of the guide rolls 26 and 27 are movable in the usual manner to change the angularity of the roll and thus guide the travel of the belt, the block and bearing for the guide roll 26 being manually movable and those for the guide roll 27 being movable by mechanical means. The stretch roll 29 is arranged for movement in a longitudinal or machine direction to increase or decrease the tension in the belt 15. The lower reach of the belt extends over the upper portions of the cylindrical surfaces of the top tier dryer cans 20, and these cans are continuously rotated (by means not shown) in a clockwise direction, as viewed in Figure 1, thereby driving the belt in an opposite or counter-clockwise direction, as viewed in this figure.

In a similar manner the bottom belt 16 extends around two guide rolls 32 and 33, a pair of stretch rolls 34 and 35 and a series of carrying rolls 36. The upper reach of the belt 16 is in contact with the lower portions of the cylindrical surfaces of the lower tier dryer cans 21. These latter cans are driven in a counterclockwise direction, as viewed in Figure 1, thereby rotating the belt 16 clockwise. The angularity of the guide rolls 32 and 33 is adjustable, in a manner similar to that described above, and the stretch roll 35 is movable in the machine direction to vary the tension in the belt.

Referring to Figure 2, there is shown a dryer belt 40 which is representative of the belts 15 and 16. The belt 40 is fabricated from three oblong sheets 42, 43 and 44 of Mylar polyester film. These sheets are ultrasonically sealed in side-by-side relationship with each other, in a manner that will become more fully apparent hereafter, to provide smooth continuous belt surfaces. The belt 40 is provided with a plurality of perforations 46 substantially entirely throughout its surface area. The perforations 46 are aligned in rows which extend in the longitudinal or machine direction of the belt and also in the transverse or cross direction. The spacing between adjacent rows of perforations is substantially equal to the diameter of each perforation and provides uninterrupted longitudinal paths 47 and transverse paths 48 of the belt material. Particularly because of the longitudinal paths 47, the reduction in the tensile strength of the material occasioned by the perforations is considerably less than would otherwise be the case.

The outermost sheets 42 and 44 of the belt 40 includes imperforate, longitudinally extending areas 50 and 51, respectively. The areas 50 and 51 extend along the outer edges of their respective sheets and serve to minimize the possibility of fraying or rupture at these edges after repeated usage.

As a result of the perforations 46, the available ranges for the porosities of dryer

belts in accordance with the various illustrated embodiments of the invention are considerably greater than those for the woven belts heretofore available. At the time the wet paper web comes in contact with each dryer can, much of the water and other liquid in the web is rapidly vaporized. With conventional, relatively bulky belts, even those of comparatively open weave construction, the belts have exhibited a blanketing effect which greatly restricted the free passage of vapor there-through from the web to the atmosphere. The perforations in the belts 15, 16 or 40, on the other hand, are such that the vapor is quickly discharged to the atmosphere.

The deleterious blanketing effect of many of the conventional dryer belts has been further augmented by their highly absorbent characteristics. Although the absorbency of the prior belts in some respects has been considered advantageous, it has been found that the accumulated moisture absorbed by the belt, unless removed, has a wetting effect on the paper web in contact with the dryer cans. Because of the substantially non-absorbent nature of the polymeric material used for the belts 15, 16 or 40, for example, much of the moisture that would otherwise be retained within the belt is discharged to the atmosphere through the perforations 46.

In the embodiment shown in Figure 2, each of the perforations 46 in the belt 40 is .045 inches in diameter, and 225 perforations are provided in each square inch of the material, giving an open area of thirty-six per cent. With this arrangement, the air permeability of the belt is over 700 cubic feet per minute per square foot at 0.5 inches water, as measured under ASTM Standard Test Procedure No. D737-46 for Air Permeability of Textiles. For comparison purposes, the air permeability of representative conventional belts woven from synthetic yarns in most cases is under 300 cubic feet per minute per square foot at 0.5 inches water.

In several advantageous embodiments, the size and orientation of the perforations 46 is within well defined limits to enable the efficient transmission of moisture through the belt from the paper web. Although the perforation size and orientation varies widely in accordance with the type of paper making machine and the particular papermaking operation being performed, for many applications the diameter of each perforation advantageously is within the range of from about 0.01 inches to about 0.25 inches, while the number of perforations per square inch ranges from about 6000 to about 10. In other arrangements, good results are obtained with perforations of a size and orientation outside these ranges. In addition, the individual perforations may be of various shapes, other than the circular form shown, without departing from the scope of the invention.

The perforations 46 are formed by punching apparatus indicated schematically at 55 (Figure 3). The apparatus 55 includes a series of cylindrical, downwardly extending punches 56 which are movable in directions perpendicular to the plane of the polymeric sheet. The lower surfaces of the punches 56 are recessed to form comparatively sharp cutting edges 57. Upon movement of the punches into the sheet of material, the material is cut away to form the perforations. In most cases, the punches are at a temperature which is well below the softening point of the material, and preferably at substantially room temperature. With this arrangement, the material to be removed from the sheet is cut cleanly, thus substantially eliminating the possibility of forming small lumps or beads of material on the sheet surfaces which might mar the paper web.

In the embodiment shown in Figure 2, the perforations 46 advantageously are formed after the sheets 42, 43 and 44 have been sealed in side-by-side relationship with each other. The perforations extend across the seals without interruption and are arranged substantially entirely throughout the surface area of the belt 40. In other arrangements, the sheets are perforated before the sealing operation. The perforations either terminate prior to the inside edges of the sheets, to provide imperforate, longitudinally extending areas of material adjacent each seal, or extend in close proximity therewith.

Upon the formation of the perforations in the belt material, the material preferably is preconditioned by the application of heat to reduce the possibility of shrinkage during the papermaking operation and also to relieve any stresses that may have developed during the formation of the perforations. The ends of the material are first temporarily connected, as by suitable staples (not shown), and the belt is then installed under tension around a portion of the cylindrical surface of one or more dryer cans, such as the cans 20 or 21 (Figure 1), for example, in a preconditioning dryer. The temperature of the cans is such that the belt is heated to a preconditioning temperature which is at least as great as that expected in its end use but is below the softening point of the material. In certain arrangements, the belt is preconditioned at a temperature of about 300°F. and is maintained at that temperature for a length of time sufficient to substantially eliminate the possibility of any residual shrinkage on the paper machine. In most cases, the preconditioning time is relatively short and illustratively is of the order of about five minutes. Thereafter, the staples are removed, and the belt is cut to the appropriate length preparatory to its installation on the machine.

In other embodiments, particularly when Type "A" Mylar polyester film is used as the

belt material, the possibility of substantial belt shrinkage on the machine is so slight that the preconditioning step is eliminated.

For papermaking machines of comparatively small size in which the paper web being produced is relatively narrow, a single sheet of incompressible polymeric material is employed as a web-carrying belt. Thus, as best shown in Figure 6, there is provided a belt 60 of Mylar polyester film which includes perforations 61 substantially entirely throughout the same. The perforations 61 are arranged in a manner similar to the perforations 46 (Figure 2) described heretofore, and the belt is provided with uninterrupted lengthwise paths 62 and transverse paths 63 between the rows of perforations. In addition, the edges of the belt form longitudinally extending imperforate areas 64 and 65. The perforations are formed and the belt is preconditioned in the manner discussed above with respect to the belts 15, 16 and 40.

The opposite longitudinal ends of the rectangular sheet material are joined to form endless dryer belts by ultrasonic welding apparatus indicated generally at 70 (Figure 7). The apparatus 70 includes a sine wave voltage source 71 which is connected to a transducer 72 by two conductors 73 and 74. The transducer 72 is of conventional construction and is arranged to impart vibratory mechanical motion at a fixed ultrasonic frequency to a welding element or horn 72a. The thickness of the portion of the horn 72a adjacent the belt, when measured in a longitudinal direction with respect thereto (the thickness  $t$  in Figure 7), preferably is approximately equal to the thickness of the belt. The horn 72a is disposed in juxtaposition with one side of the belt material, while the opposite side rests on a stationary table 75.

The apparatus 70 is arranged to join opposite ends of either a multi-sheet belt, such as the belt 40 shown in Figure 2, for example, or a single sheet belt, such as the belt 60 of Figures 6 and 7. In some embodiments, each end of the belt to be joined is provided with a forty-five degree bevel 78. The ends are then clamped on a movable fixture (not visible in Figure 7), and the belt is moved along the table 75 in a transverse direction. The vibratory motion of the horn 72a forms a permanent weld or seal 80 along the beveled edges of the belt with little or no interruption in the smooth continuity of the belt surfaces.

Particularly for comparatively long seals, the belt may be held stationary, and the apparatus 70 moved in a transverse direction to form the seal. In addition, in some cases the bevels 78 are omitted, and the belt ends are placed in overlapping relationship with each other prior to sealing. In these latter situations, the amount of overlay preferably is at least equal to the thickness of the belt.

The ultrasonic sealing apparatus 70 also is effective to form longitudinal seals, such as the seals 82 and 83 (Figure 2) between the three oblong sheets 42, 43 and 44 of the belt 40. The seals 82 and 83 are of the overlapping type and are formed by moving the sheets relative to the apparatus 70 in a manner similar to that described heretofore. In addition, the apparatus is advantageous in the formation of transverse or oblique seals between adjacent sheets, as in cases in which the belt comprises successive side-by-side sheets which extend in the cross machine direction, for example.

Although the use of ultrasonic sealing apparatus is advantageous in the formation of dryer belts in accordance with several embodiments of the invention, in other arrangements the polymeric material is adhesively interconnected or is joined by lamination or other suitable techniques. As an illustration, particularly for comparatively low-temperature dryers, a polyester tape of the type available commercially from the G. T. Schjeldahl Company, Northfield, Minnesota, may be used to unite the ends of a single sheet belt, for example, or to hold adjacent sheets of a multi-sheet belt in side-by-side relationship with each other.

Figures 8-11 are illustrative of various alternative connections between the ends of dryer belts in accordance with the invention. In Figures 8 and 9 there is shown a perforated dryer belt 85 of Mylar polyester film. The ends 87 and 88 of the belt 85 are folded back upon themselves and are each held in place by three transverse rows of stitching 90. The folds in the ends 87 and 88 are notched to provide integrally formed loops 91 and 92, respectively, which are positioned in interleaved relationship with each other. An elongated rod or pintle 94 is inserted through the loops 91 and 92 to connect the ends of the belt and thereby form an endless construction.

Referring to Figures 10 and 11, there is provided a perforated belt 95 of Mylar polyester film having substantially flat end portions 96 and 97. The end portion 96 includes a transversely extending web 100 of woven material, such as "Dacron", for example, which is held in place by stitching 101. (The word "Dacron" is a registered Trade Mark). The end portion 97 similarly includes a woven web 102 secured to the belt by stitching 103. A plurality of clipper hooks 105 is sewn into the web 100 and are interleaved with corresponding clipper hooks 106 in the web 102. The hooks 105 and 106 accommodate a pintle 108 to hold the ends of the belt in fixed but flexible relationship with each other.

In several advantageous embodiments, after the ends of the polymeric sheet material have been interconnected to form an endless dryer

belt, the belt is inserted in an operative position around the dryer drums 20 or 21 (Figure 1) of the papermaking machine. Certain of the rolls in the drying section are either removed or temporarily supported during the removal of appropriate portions of the machine frame, and the belt is trained around the dryer drums and the remaining rolls. The removed rolls and frame portions are then replaced, and the corresponding stretch roll 29 or 35 is adjusted to place the belt under proper tension.

In other arrangements, the belt is positioned around the dryer drums and rolls prior to the joining of its ends to provide an endless construction. In these latter situations, the belt is threaded through the dryer section and the ends are then ultrasonically sealed or otherwise interconnected in the manner described above. The stretch rolls are adjusted in the usual manner to place the proper tension on the belt.

Referring now to Figure 4, there is shown a dryer belt 110 which comprises a non-woven fibrous batt 111 laminated to a sheet 112 of Mylar polyester film. The batt 111 is formed from either natural or synthetic fibers, such as various heat resistant cottons, for example, or nylon or other synthetic fibers, or from blends of natural and synthetic fibers. In some cases, the batt is pre-formed, as by needling, felting, chemical bonding, or other conventional process. Particularly in cases in which the fibers forming the batt are to be given a predetermined orientation, however, the individual fibers are deposited electrostatically on the sheet 112. A suitable adhesive 114, such as one of the polyurethane resins, for example, is used to secure the batt 111 to the sheet 112. A polyurethane resin which has been found to be particularly useful for this purpose is Unithane Resin 390T, which is a trade name of the Thiokol Chemical Corporation, Trenton, New Jersey.

The sheet 112 includes a series of perforations 113 therein and is generally similar to the various dryer belts described heretofore. Upon the application of the batt 111 thereto, the ends of the sheet are joined ultrasonically or otherwise interconnected to provide an endless construction. In cases in which ultrasonic seals are employed, the ends preferably are left bare until the completion of the seal and are then provided with a suitable strip of the batt material.

Figure 5 is illustrative of a layer 115 of opencell plastic foam which is laminated to a sheet 116 of Mylar polyester film to form a dryer belt 120. The layer 115 preferably comprises a polyurethane resin, the polyether resins of this type having exhibited particular utility in this regard. The sheet 116 is substantially the same as the dryer belts 40 or 60, for example, and includes perforations 121 arranged in a manner similar to that discussed

above. A suitable adhesive 122, such as Uni-  
thane Resin 390T, for example, is employed  
to secure the foam 115 to the sheet 116.

5 The laminated belts 110 and 120 are used  
as the paper web carrier in the drying section  
of a papermaking machine in a manner gener-  
ally similar to the belts 15 and 16 (Figure 1)  
described heretofore. The belts 110 and 120  
10 are particularly advantageous at the infeed or  
wet end of the drying section, and in some  
cases are followed by non-laminated belts such  
as the belts 15 and 16. Thus, as best shown  
in Figure 1, the infeed end of the drying  
15 section is provided with a top belt 120a and  
a bottom belt 120b, of the type shown in  
Figure 5, for example. These belts are trained  
around suitable rollers 125 and 126 with the  
foam 115 thereon in contact with the paper  
web 22.

20 The laminated belts 110 and 120 have  
exhibited comparatively high insulating prop-  
erties. These properties are particularly im-  
portant as the paper web is advanced toward  
the hot press rolls sometimes provided adja-  
25 cent the wet end of the drying section and  
greatly facilitate the retention of heat by the  
web. In the dry or outfeed portion of the  
drying section, the increased porosity of the  
non-laminated belts 15 and 16 further en-  
30 hance the drying action.

In order to describe more clearly the nature  
of the present invention, the following exam-  
ples illustrating the invention are disclosed. It  
should be understood, however, that this is  
35 done solely by way of example and is intended  
neither to delineate the scope of the invention  
nor limit the ambit of the appended claims.

#### EXAMPLE I

40 Dryer belts were prepared from sheets of  
Type "A" Mylar polyester film having a  
thickness of 10 mils and were perforated sub-  
stantially entirely throughout their surface  
area by the application of punches at sub-  
stantially room temperature. The perforations  
45 were oriented in the manner shown in Figure  
2, with uninterrupted paths of the belt material  
extending in both the machine direction and  
in the cross machine direction. The diameter  
of each perforation was 0.045 inches and there  
50 were 225 perforations per square inch, giving  
an open area of thirty-six per cent and an  
air permeability of over 700 cubic feet per  
minute per square foot at 0.5 inches water  
when measured under the conditions referred  
55 to heretofore. The perforated sheets were  
arranged in pairs which were ultrasonically  
sealed in side-by-side relationship with each  
other to form belts 50 inches wide. Each belt  
was maintained under tension at a precondition-  
60 ing temperature of 250°F. for five minutes,  
during which time the transverse dimension  
of the belt was reduced by 0.375 inches.

The ends of the belts were interconnected  
by pintles and clipper hooks of the type shown

65 in Figures 10 and 11, and the belts were  
mounted in the second drying section of an  
experimental papermaking machine located at  
the State School of Forestry, Syracuse, Uni-  
versity, Syracuse, New York. The arrange-  
ment of the belts was substantially as shown  
70 by the top belt 15 and the bottom belt 16 in  
Figure 1. The length of the top belt was  
57.5 feet and that of the bottom belt was  
51.5 feet. The stretch rolls for each belt were  
adjusted until the belt tension approximated  
75 10 pounds per linear inch. The steam pressure  
in the dryer cans ranged between 10 pounds  
per square inch and 20 pounds per square  
inch, and the maximum temperature of the  
cans 240°F.

80 A web of medium grade bond paper was  
threaded through the machine, and the  
machine was operated at a speed of 185 feet  
per minute. Upon entering the drying section,  
the web had a consistency of 71.1 per cent.  
85 At the time the web was discharged, its  
consistency was 96.8 per cent, 0.370 pounds  
of water having been removed per pound of  
paper. The dried web was of high quality  
with no evidence of surface markings.  
90

#### EXAMPLE II

95 As another example of the effectiveness  
of the method and apparatus of the inven-  
tion, perforated sheets of Type "A" Mylar  
polyester film were prepared and precondition-  
ed in accordance with Example I. An  
open-cell polyurethane foam, available com-  
mercially from the General Foam Corporation,  
New York, New York, under its trade name  
Polyurethane Foam GF-30, was laminated  
100 to each sheet and was adhesively secured  
in place through the use of Unithane Resin  
390T. The density of the foam was 2 pounds  
per cubic foot, and its thickness was 0.25  
105 inches. The air permeability of the assembled  
belts was 101 cubic feet per minute per square  
foot at 0.5 inches water, measured in accord-  
ance with the above-noted procedure.

110 The ends of the laminated belts were sealed  
ultrasonically, and the belts were arranged in  
an operative position in the second section  
of the experimental paper machine used for  
Example I. A moist paper web was run  
through the machine under substantially the  
115 same conditions. The consistency of the web  
as it entered the drying section was 54.65  
per cent and on leaving the dryer section was  
92.45 per cent; 0.748 pounds of water were  
removed per pound of paper. No evidence of  
120 sheet marking was observed.

125 In cases in which laminated belts are em-  
ployed in the dryer section of a papermaking  
machine, in some embodiments various con-  
structions other than the fiber or foam lami-  
nations described heretofore may be used with  
good effect. For example, a plurality of sheets  
of polymeric material may be laminated  
together to form various sandwich construc-

tions. Also, a wide variety of coating materials may be applied to one or both surfaces of the assembled belt to further enhance the belt's resistance to heat, hydrolysis, soiling, etc.

When used in the initial portion of the drying section of a papermaking machine, dryer belts in accordance with some embodiments of the invention may be employed to carry the paper web between certain of the press rolls in the wet section of the machine before being led around the dryer drums. As an illustration, the endless paths for the laminated belts 120a and 120b (Figure 1), for example, may be such that the belts extend around the last press rolls in the wet section and serve to carry the paper web between these rolls and to then transfer the web to the drying section. Also, in those types of machines which employ an initial or predrying section followed by opposed hot press rolls, the laminated belts advantageously may extend between these latter rolls on opposite sides of the web.

Although the invention has been shown and described as having particular utility when used in the drying section of a papermaking machine, it will be apparent to those skilled in the art that the invention also may be employed advantageously for other drying applications. Thus, for example, the invention may be used effectively in machines for drying fabrics or other sheet materials.

While the form of the present invention hereinbefore described has included perforations in the sheet material, it has been found that the invention is operative, although with less efficiency, without any perforations in the belt.

The terms and expressions which have been employed are used as terms of description and not of limitation, and there is no intention in the use of such terms and expressions of excluding any equivalents of the features shown and described, or portions thereof, it being recognized that various modifications are possible within the scope of the invention claimed.

#### WHAT WE CLAIM IS:—

1. A dryer belt for the drying section of a papermaking or similar machine which belt is adapted to be moved in an endless path in said machine and is formed of material permitting the transmission of moisture there-through from said web, the material comprising substantially incompressible polymeric sheet material.

2. A dryer belt according to claim 1, wherein the sheet material comprises polyethylene terephthalate film.

3. A dryer belt according to claim 1 or 2, wherein the sheet material has a thickness within the range of from 5.0 mils to 28.0 mils.

4. A dryer belt according to any one of claims 1 to 3, wherein the sheet material is

provided with perforations therein, with unperforated portions of the sheet material extending in the longitudinal direction of the belt.

5. A dryer belt according to claim 4, wherein the diameter of each of the perforations is within the range of from 0.01 inches to 0.25 inches and the number of perforations per square inch ranges from 6000 to 10.

6. A dryer belt according to any one of the preceding claims, wherein means are provided affixed to the ends of the sheet material which are connected to form an endless loop of said material.

7. A dryer belt according to any one of claims 1 to 5, wherein the ends of the sheet material are joined ultrasonically to form an endless loop of said material.

8. A dryer belt according to any one of the preceding claims, wherein two or more sheets of the material are joined side-by-side preferably by ultrasonic means, to form a belt of a desired width.

9. A dryer belt according to any one of the preceding claims, wherein there is laminated to one surface of the sheet material a layer of compressible material such as an open-cell foam or a batt of fibrous material.

10. A method of producing a belt as defined in claim 1, which comprises forming a sheet of substantially incompressible polymeric material such as polyethylene terephthalate and joining the end portions of said sheet to form a belt movable in an endless path.

11. A method according to claim 10 which includes perforating said sheet to provide a series of spaced perforations substantially entirely throughout the same, preferably with uninterrupted paths of said material extending longitudinally of the belt.

12. A method according to claim 10 or 11, which includes ultrasonically joining opposite ends of said sheet to form an endless belt.

13. A method according to any one of claims 10 to 12, which includes ultrasonically joining two or more sheets side-by-side to form a belt of a desired width.

14. A method according to any one of claims 10 to 13, which includes applying a layer of compressible material such as open-cell foam or a batt of fibrous material to one surface of the sheet.

15. A method according to claim 14, wherein a fibrous batt is applied to said sheet by electrostatically depositing the fibers thereof on said one surface.

16. A method according to any one of claims 10 to 15, wherein said sheets are placed under tension, and are pre-conditioned while under said tension by heating the same for a predetermined time to a temperature at least as great as that encountered in the use of said belt on a papermaking or similar machine.



- 
17. A dryer belt for the drying section of a papermaking or similar machine, substantially as hereinbefore described with reference to the accompanying drawings.
- 5 18. A method of producing a belt as defined in claim 1, substantially as hereinbefore described with reference to the accompanying drawings.

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Agents for the Applicants.

Leamington Spa: Printed for Her Majesty's Stationery Office by the Courier Press.—1966.  
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

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**POOR QUALITY**

1016649

COMPLETE SPECIFICATION

3 SHEETS

This drawing is a reproduction of  
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Sheet 1

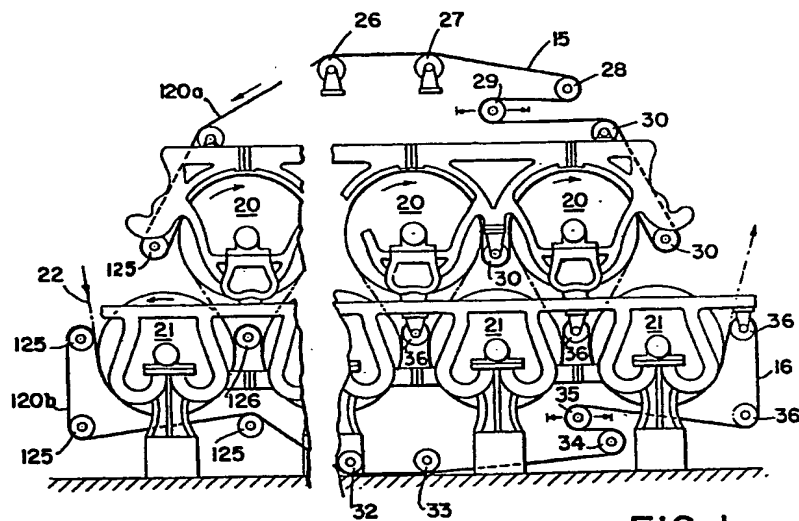


FIG. 1

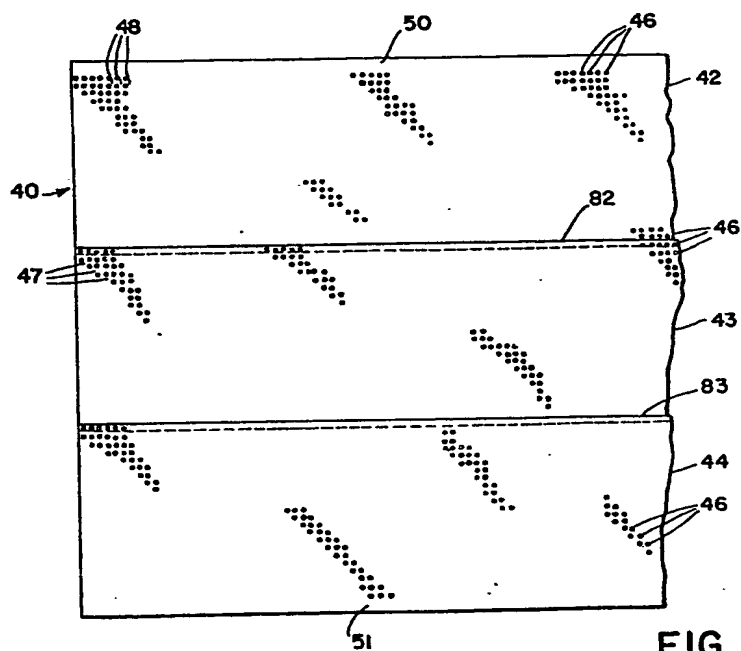


FIG. 2

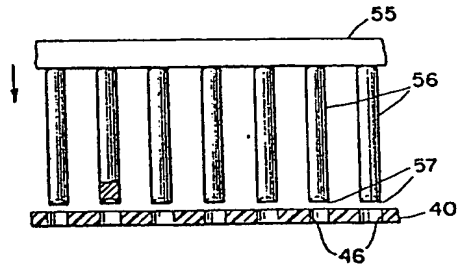


FIG. 3

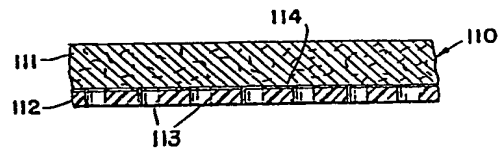


FIG. 4

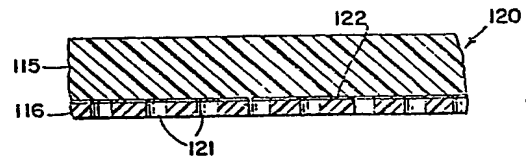


FIG. 5

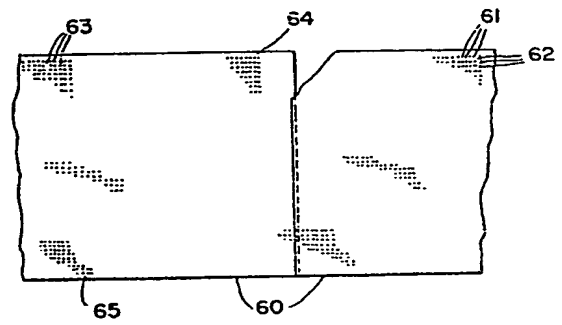


FIG. 6

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COMPLETE SPECIFICATION

3 SHEETS

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Sheets 2 & 3

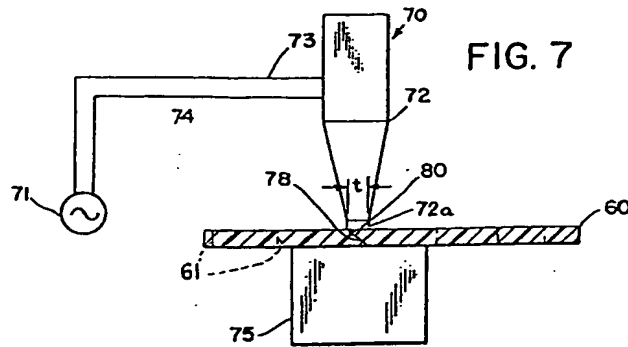


FIG. 7

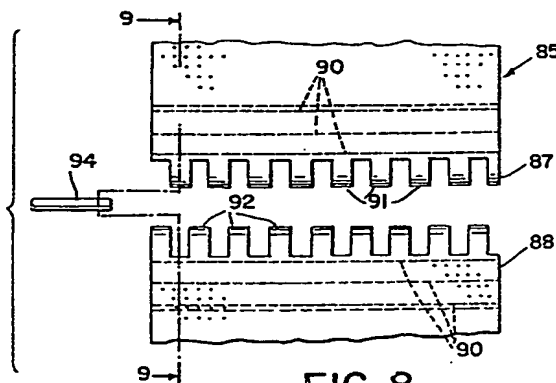


FIG. 8

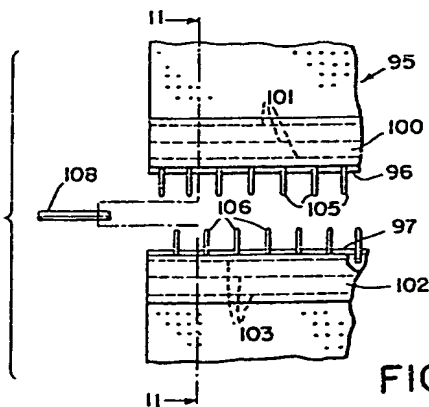


FIG. 10

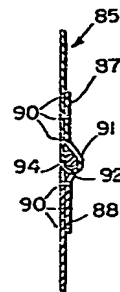


FIG. 9

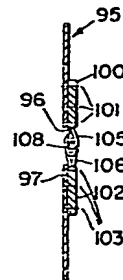


FIG. 11

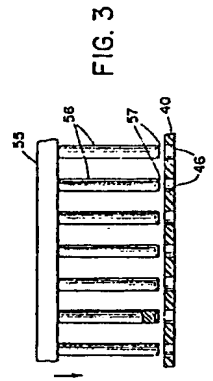


FIG. 3

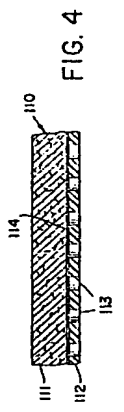


FIG. 4

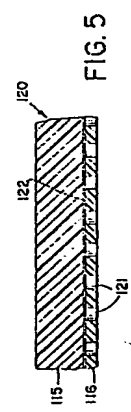


FIG. 5

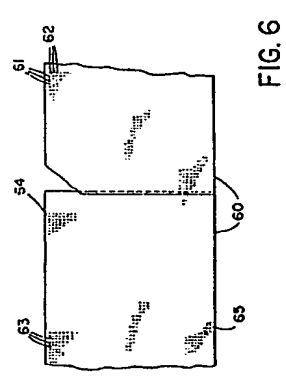


FIG. 6

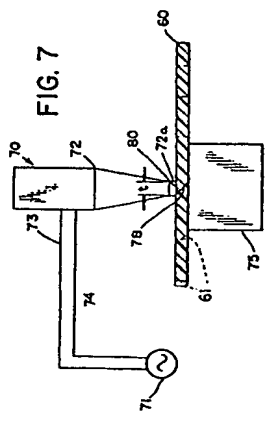


FIG. 7

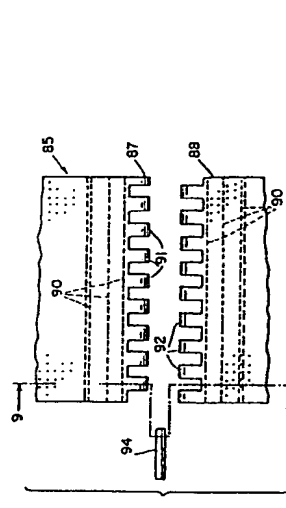


FIG. 8

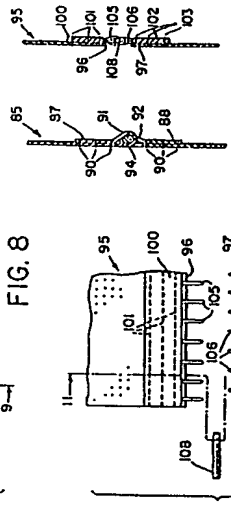


FIG. 9

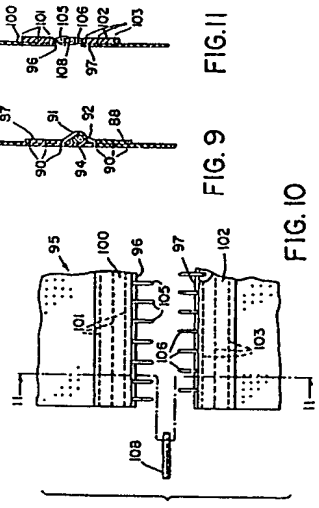


FIG. 10

FIG. 11